REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE 05/07/76	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
DETERMINATION OF DECONTAMINATION CRITERIA, DIMP AND DCPD (U)

5. FUNDING NUMBERS
DAMD 17 75 C 5069

6. AUTHOR(S)
O'DONOVAN, P.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AEROJET ORDNANCE & MANUFACTURING COMPANY
DOWNEY, CA

8. PERFORMING ORGANIZATION REPORT NUMBER
81335R03

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
FORT DETRICK (FREDERICK, MD.)
FREDERICK, MD

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

THIS IS A PROGRESS REPORT ON AEROJET'S STUDIES OF EXPERIMENTS CURRENTLY UNDERWAY (E.G., PLANT GROWTH AND DIMP AND DCPD LYSIMETER TESTS.) THE FULL SCALE LYSIMETER TESTS ARE CONTINUING. A NEW SET OF FIVE LYSIMETERS WAS INOCULATED WITH DIMP ON APRIL 21, 1976. THE FIRST SET OF LYSIMETER TESTS IS CONTINUING. THE ANALYSIS OF THE HARVESTED PLANT TISSUES FROM THE RANGE FINDING GROWTH TESTS HAVE CONTINUED. CONSTRUCTION OF THE NEW THREE ROOM, 14 X 42 FOOT GREENHOUSE TO BE USED IN THE SOIL CULTURE EXPERIMENTS HAS BEEN COMPLETED AND HAS BEEN OUTFITTED WITH HEATERS AND COOLERS.

14. SUBJECT TERMS
CONTAMINANTS, FLORA, SOIL, CHEMICALS, LYSIMETER

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED			

81335R03
Original

AEROJET ORDNANCE AND MANUFACTURING COMPANY
9236 East Hall Road
Downey, California 90241

DETERMINATION OF DECONTAMINATION CRITERIA

DIMP AND DCPD (U)

Report No. 1953-01(10)MP

Contract DAMD-17-75-C-5069

to

U.S.ARMY, Ft. Detrick

Fredrick, Maryland 21701

Prepared by: P. A. O'Donovan

P. A. O'Donovan

Date: 7 May 1976

No. of Pages: 24

FILE COPY

Progress on items proposed for action during April, 1976 is discussed in the following paragraphs.

FULL SCALE LYSIMETER TESTS

The full scale lysimeter tests are continuing. A new set of five lysimeters was inoculated with DIMP on April 21, 1976. In this case a one foot thick layer of top soil from each of five lysimeters was intimately mixed in a portable cement mixer with enough DIMP (diisopropyl methyl phosphonate) to produce a mixture containing 20 parts per million (ppm) of DIMP. This mixture was then re-packed in the lysimeter on top of a four foot deep column of subsoil which has been saturated with water and drained. These lysimeters are equipped with tensiometers at the midpoint of each one foot layer of soil to enable samples of the water to be taken at different levels.

Fresh distilled water is being added to the top of the lysimeters in the amount of two inches (12,887 cc) per week and the water and soil sampled at intervals for analysis.

The total amount of agent contained in each of the lysimeters is as follows:

Chino	-	sandy clay loam	-	5.60 g.
Brawley	-	silty clay	-	5.22 g.
Ventura	-	clay loam	-	5.98 g.
Fullerton	-	sandy loam	-	5.22 g.
Walnut	-	clay loam	-	5.35 g.

The anticipated water addition rate is the same as the starting rate for the first group of lysimeters, that is, one addition of two inches depth per week. If the water passage becomes too slow it will be changed to a two week addition cycle.

The tensiometer samples from the first week's drainage showed no significant amount of DIMP below the one foot level.

The first set of lysimeter tests is continuing. This consists of an identical set of lysimeters to those described above which are subjected to the addition of two inches of water every two weeks which contains 20 ppm DIMP and the analysis of core and tensiometer samples at timed intervals. The amount of water which passes through the lysimeter is measured and a term, "drainage efficiency," is used to describe the water flow. (Drainage Efficiency = amount of water drained during the period ÷ 12,887 cc [original input volume]). The drainage efficiency figures for this series are plotted in Figure 1.

Analysis of the tensiometer water samples for DIMP has been made as in previous periods. The analytical data is shown in Table 1. Plots of the average values for April versus the average values for all preceding months are given in Figures 2a, 2b, 2c, 2d and 2e. It appears, in general, that the various levels are getting richer in DIMP as time passes and that, except for the Ventura clay loam, the concentration of DIMP drops off with depth in the lysimeter.

Core samples of the lysimeter soil have been run also. Calculations of DIMP recovery versus time and position have been made as in previous reports. Tables II and IIIa, b, c, d, e show the data from these core samples.

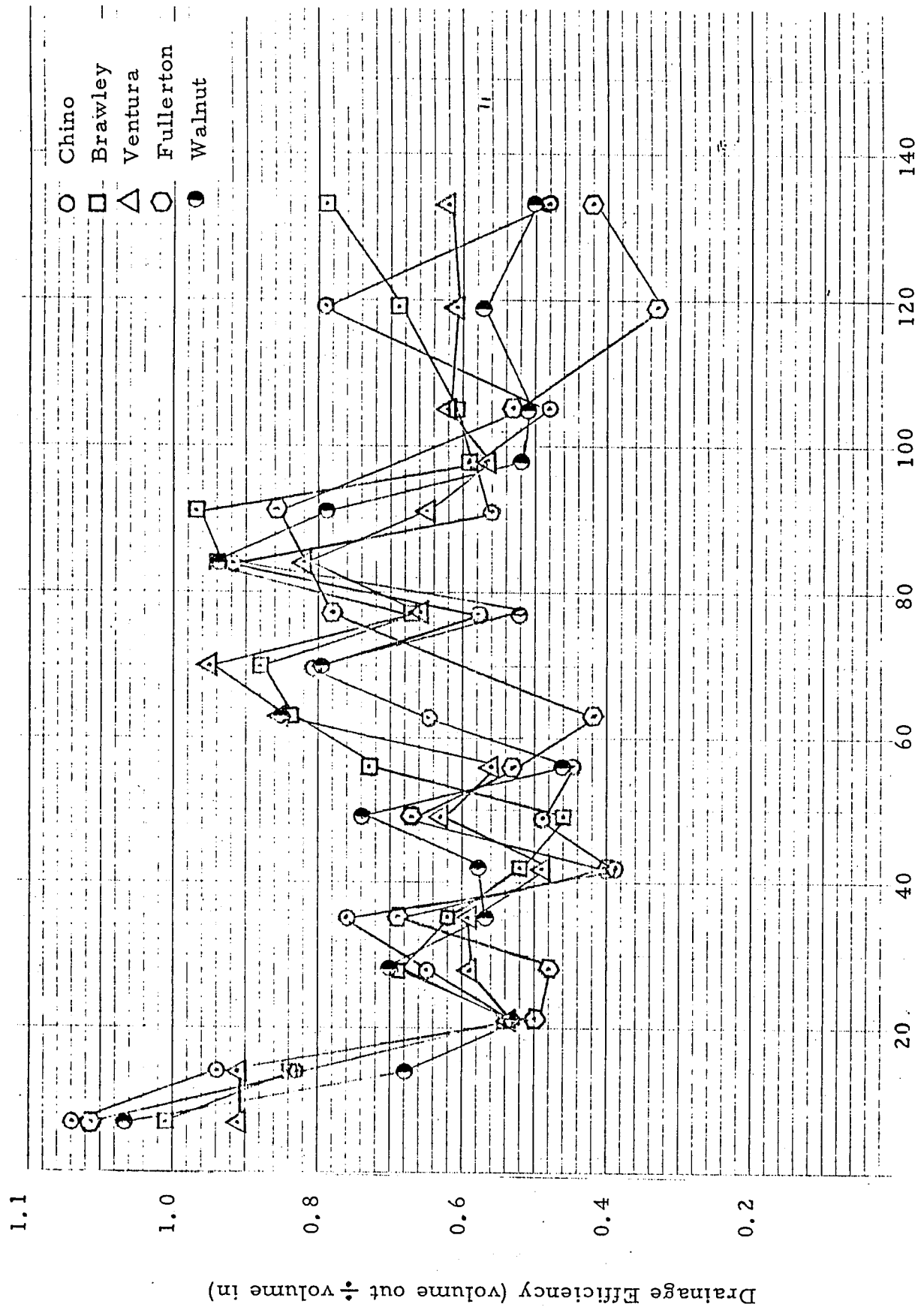

Figure 1. Drainage Efficiencies of Various Soils in Full Scale Lysimeters

Table 1

Type	Depth	Average from Previous Samples	DIMP (ppm) Days Since Inoculation 112	119	128	Average this Month
Ventura	6"	1.75	2.65	2.27	2.88	2.60
	18"	0.31	----	1.18	0.97	1.08
	30"	0.28	0.11	0.21	0.34	0.22
	42"	0.36	0.58	0.78	1.08	0.82
	54"	0.58	1.27	1.63	2.63	1.85
	60"	2.65	3.23	3.26	3.26	3.25
Chino	6"	1.50	4.82	3.84	7.98	5.55
	18"	0.79	2.26	3.80	7.18	4.42
	30"	0.66	1.91	2.86	----	2.39
	42"	0.20	2.14	2.60	----	2.37
	54"	0.14	0.89	1.37	2.86	1.71
	60"	0.28	1.30	1.27	2.74	1.77
Fullerton	6"	5.79	4.36	3.64	5.69	4.55
	18"	2.33	2.75	2.50	4.05	3.10
	30"	0.50	1.25	1,55	2.82	1.87
	42"	1.43	0.71	0.86	1.55	1.04
	54"	0.20	0.51	0.51	1.16	0.73
	60"	0.61	0.73	0.60	1.15	0.83
Walnut	6"	1.83	----	----	5.47	5.47
	18"	2.27	1.49	1.96	5.09	2.85
	30"	0.94	1.81	2.66	4.00	2.83
	42"	0.94	1.41	2.10	4.53	2.68
	54"	0.24	0.25	1.26	2.25	1.25
	60"	0.19	1.06	1.40	2.48	1.65
Brawley	6"	3.18	3.28	3.55	8.87	5.23
	18"	1.27	----	3.45	7.69	5.57
	30"	0.50	1.32	1.93	5.95	3.07
	42"	0.41	1.13	2.21	5.76	3.03
	54"	0.83	0.66	0.74	2.21	1.20
	60"	0.42	1.41	1.59	4.52	2.51

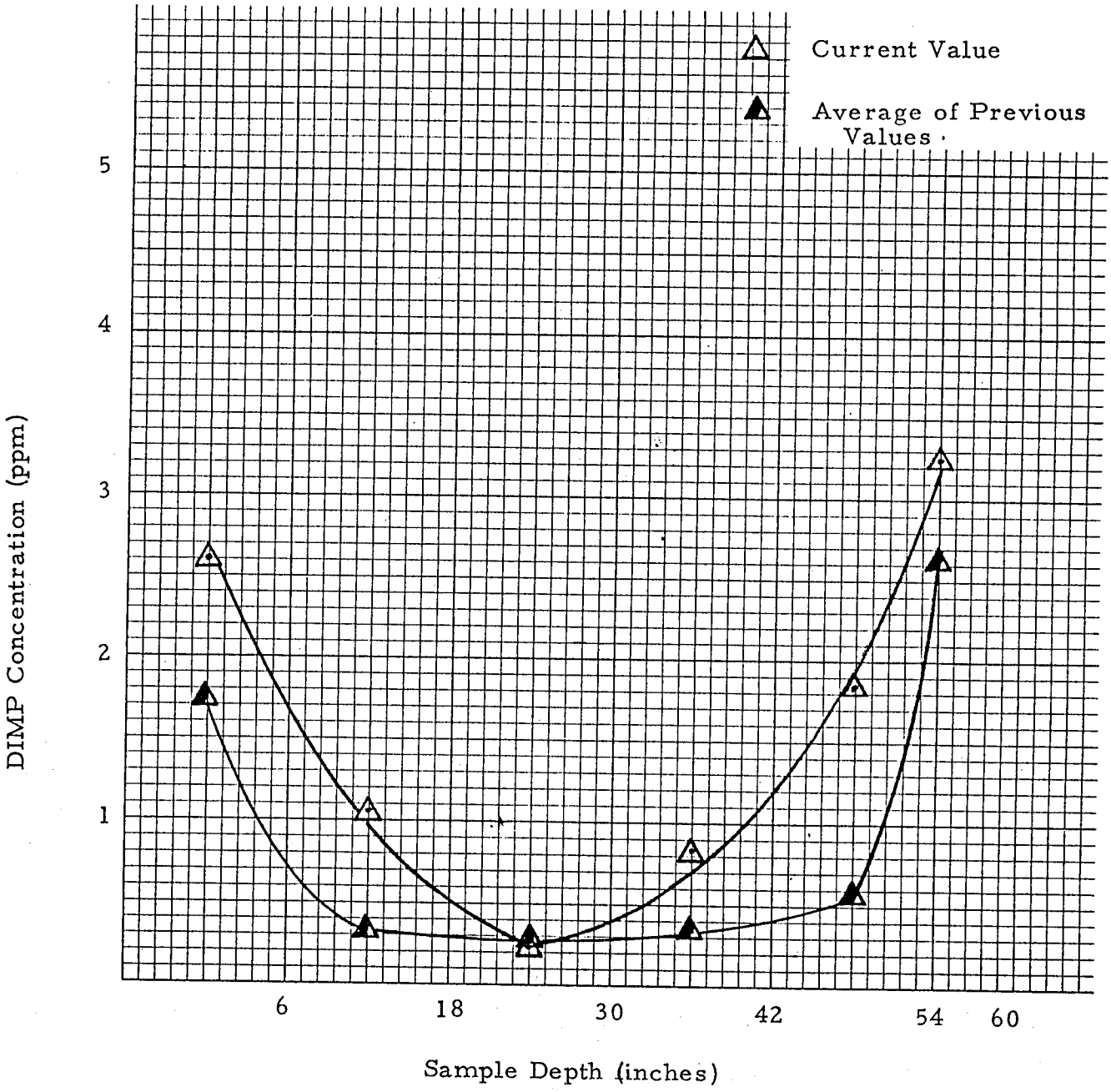

Figure 2 a. DIMP Content of Tensiometer water samples. (Ventura)

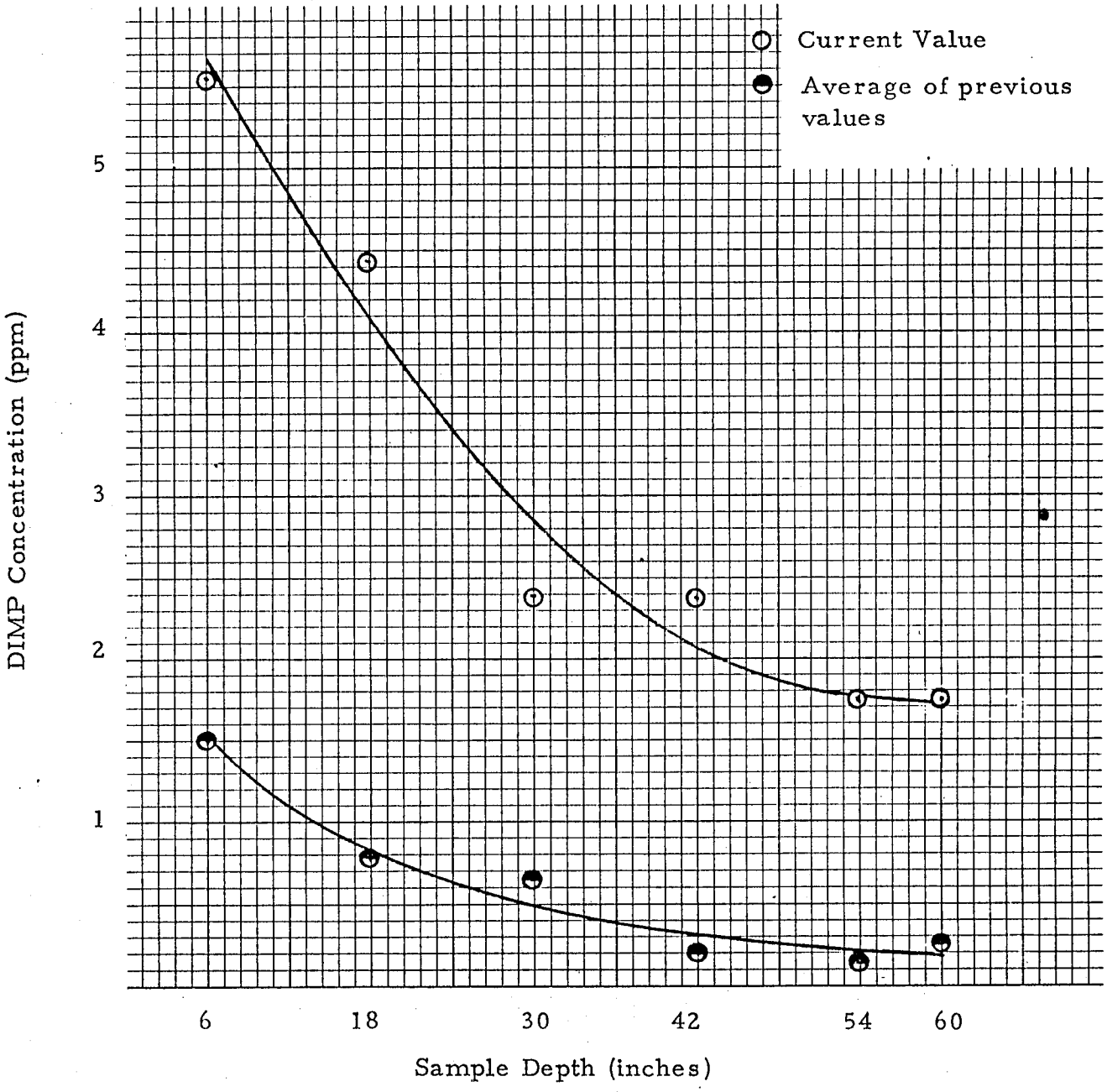

Figure 2b. DIMP Content of Tensiometer water samples (Chino)

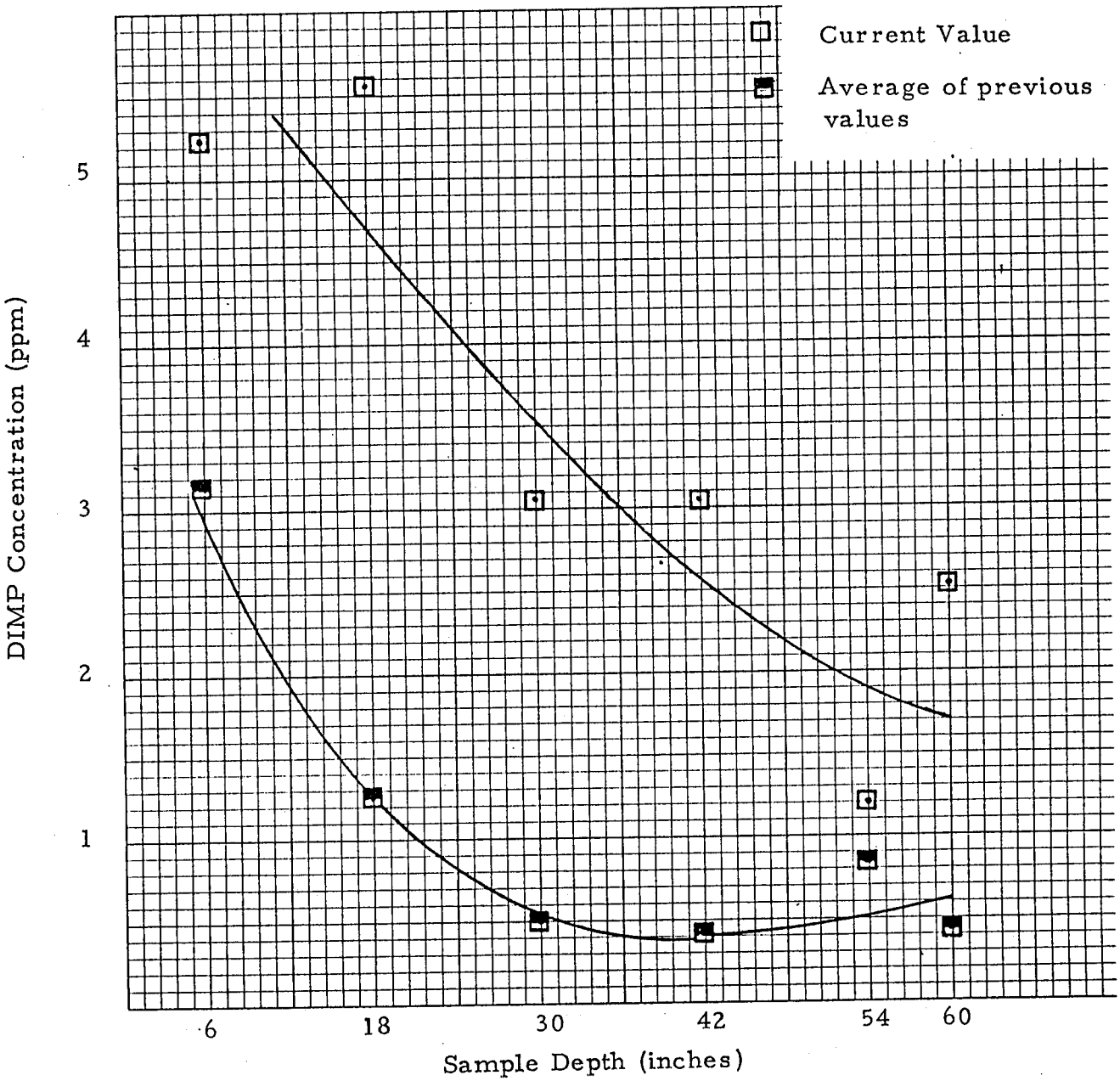

Figure 2c DIMP Content of Tensiometer water samples (Brawley)

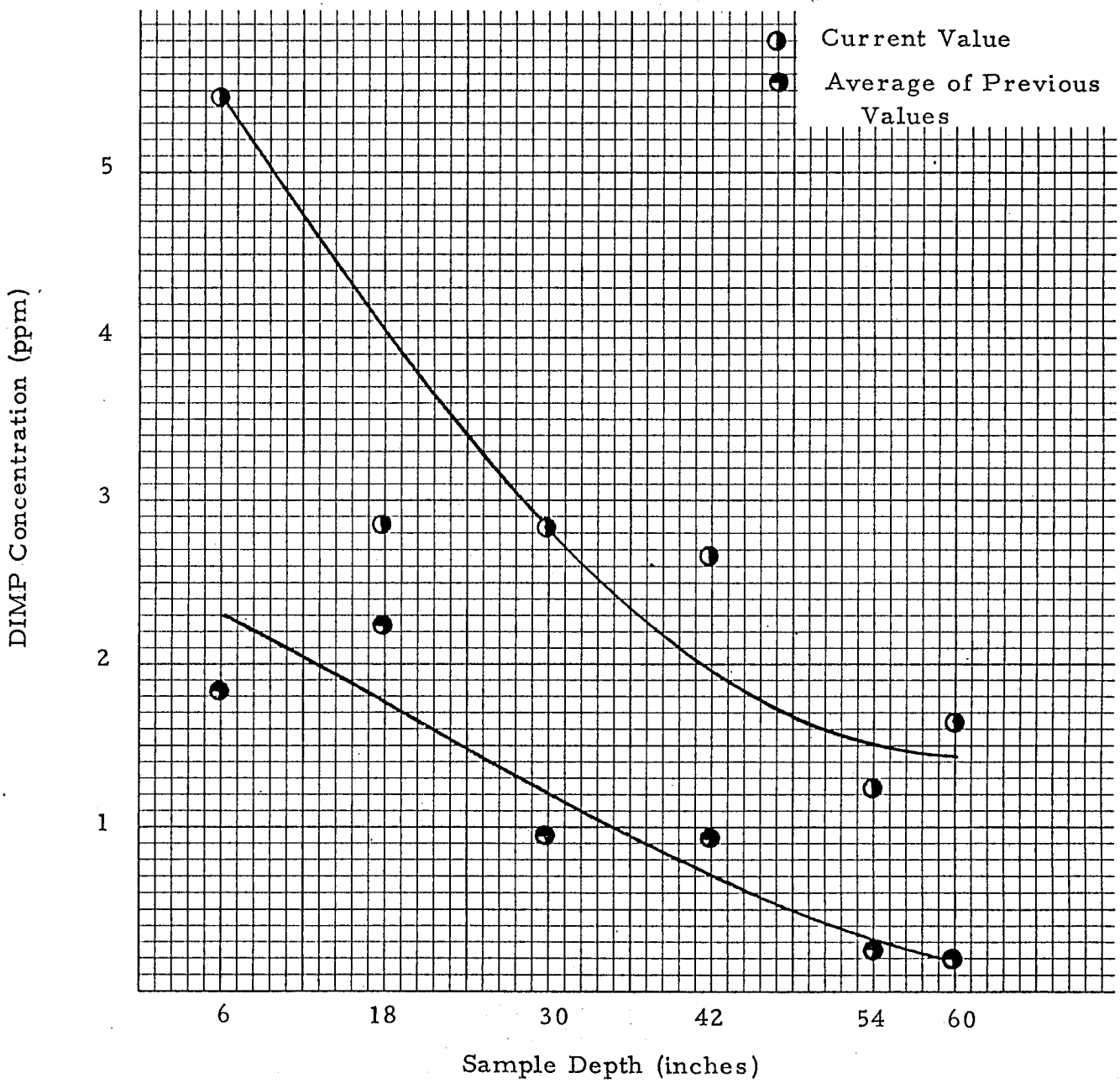

Figure 2d DIMP Content of Tensiometer Water Samples (Walnut)

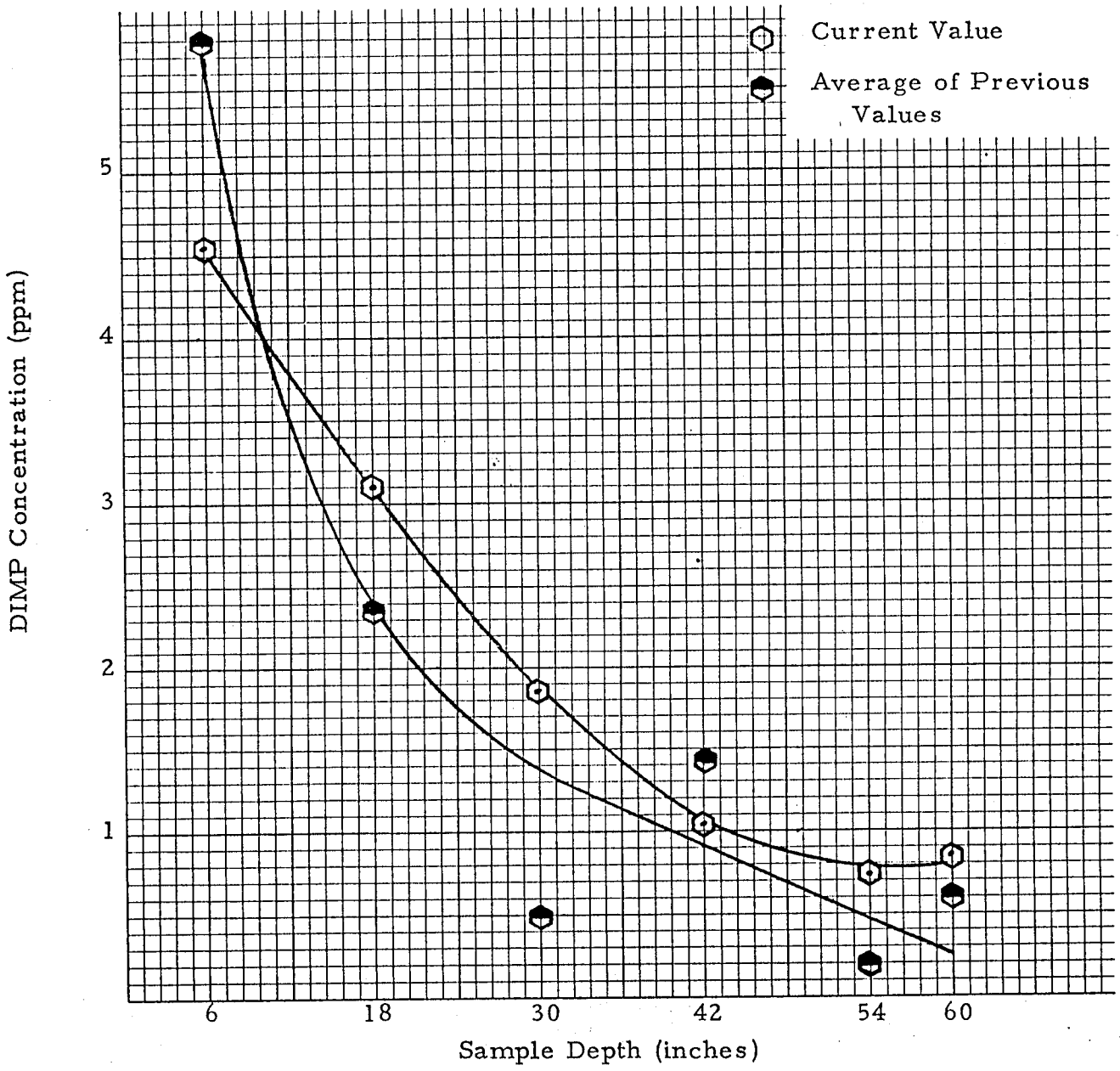

Figure 2e DIMP Content of Tensiometer Water Samples (Fullerton)

Table II

DIMP Content of Soil Samples (ppm) (133 days)

Depth	Ventura	Chino	Fullerton	Walnut	Brawley
0(surface)	15.77	20.66	11.61	9.49	19.85
0 - 6"	3.07	10.10	5.70	10.54*	5.71
6 - 12"	3.47	7.34	6.45	4.75	3.10 *
12 - 18"	1.46	4.81	3.88	5.11	2.71 *
18 - 24"	1.07	4.34	3.51	4.07	2.53 *
24 - 30"	1.37	4.21	3.93	4.61	2.32 *
30 - 36"	1.92	4.96	3.14	4.67	3.92
36 - 42"	2.20	4.10	4.36	3.82	3.98
42 - 48"	2.58	3.17	3.08	4.83	3.58
48 - 54"	2.26	3.57	3.03	3.00	3.27
54 - 60"	2.97	2.80	2.19	2.09	3.88

* Est.

Table III(a)

DIMP Content of Lysimeters 133 days

Ventura Soil	Sample Wt. (g)	Section Wt. (g)	Conc. of DIMP/Sample (ppm)	Wt. of DIMP in Total Section (g)	% Recovery
Zero-Surface	2.5 g	2465	15.77	0.039	
0 - 6"	31.1 g	30659	3.07	0.094	
6 - 12"	39.7g	39137	3.47	0.136	
12 - 18"	29.4g	28983	1.46	0.042	
18 - 24"	19.1g	18829	1.07	0.020	
24 - 30"	36.8g	36278	1.37	0.050	
30 - 36"	27.2g	26814	1.92	0.051	
36 - 42"	36.6g	36081	2.20	0.079	
42 - 48"	39.7g	39137	2.58	0.101	
48 - 54"	48.1g	47418	2.26	0.107	
54 - 60"	84.6g	83399	2.97	0.248	
Total	394.8	389200		0.967	22.07

17 additions @ 0.2577g. each = 4.3809 g. Total DIMP added

Table III(b)

DIMP Content of Lysimeters 133 days

Chino Soil	Sample Wt. (g)	Total Section Wt. (g)	Conc. of DIMP/Sample (ppm)	Wt. of DIMP in Total Section (g)	% Recovery
Zero-Surface	2.3	2,228	20.66	0.046	
0 - 6"	28.8	28,391	10.10	0.287	
6 - 12"	48.5	47,812	7.34	0.351	
12 - 18"	44.8	44,164	4.81	0.212	
18 - 24"	69.6	68,612	4.34	0.298	
24 - 30"	52.9	52,149	4.21	0.220	
30 - 36"	60.6	59,740	4.96	0.296	
36 - 42"	61.1	60,233	4.10	0.247	
42 - 48"	64.5	63,585	3.17	0.202	
48 - 54"	60.7	59,839	3.57	0.214	
54 - 60"	59.6	58,754	2.80	0.165	
Total	553.4	545,507		2.538	57.9

17 additions @ 0.2577 g. each = 4.3809 g. total DIMP added.

Table III(c)

DIMP Content of Lysimeters 133 days

Brawley Soil	Sample Wt.(g)	Total Section Wt.(g)	Conc. of DIMP/Sample (ppm)	Wt. of DIMP in Total Section (g)	Recovery
Zero-Surface	1.92	1893	19.85	0.038	
0 - 6"	27.2	26814	5.71	0.153	
6 - 12"	21.2	20899	3.10	0.065	
12 - 18"	6.9	6802	2.71	0.018	
18 - 24"	17.9	17646	2.53	0.045	
24 - 30"	7.3	7196	2.32	0.017	
30 - 36"	22.9	22575	3.92	0.088	
36 - 42"	27.3	26913	3.98	0.107	
42 - 48"	41.6	41010	3.58	0.147	
48 - 54"	54.7	53924	3.27	0.176	
54 - 60"	90.5	89216	3.88	0.346	
Total	269.42	314888		1.20	27.4

17 additions @ 0.2577 g each = 4.3809 total DIMP added.

Table III(d)

DIMP Content of Lysimeters 133 days

Walnut Soil	Sample Wt.(g)	Total Section Wt.(g)	Conc. of DIMP/Sample (ppm)	Wt. of DIMP in Total Section (g)	Recovery
Zero-Surface	5.3	5225	9.49	0.050	
0 - 6"	10.1	9957	10.54	0.105	
6 - 12"	38.2	37658	4.75	0.179	
12 - 18"	26.5	26124	5.11	0.133	
18 - 24"	38.8	38249	4.07	0.156	
24 - 30"	36.6	36081	4.61	0.166	
30 - 36"	27.9	27504	4.67	0.128	
36 - 42"	27.1	26715	3.82	0.102	
42 - 48"	15.9	15674	4.83	0.076	
48 - 54"	13.3	13111	3.00	0.039	
54 - 60"	61.4	60529	2.09	0.127	
Total	301.1	296827		1.261	28.78

17 additions @ 0.2577 g. each = 4.3809 g. Total DIMP added.

Table III(e)

DIMP Content of Lysimeters 133 days

Fullerton Soil	Sample Wt.(g)	Total Section Wt.(g)	Conc. of DIMP/Sample (ppm)	Wt. of DIMP in total Section (g)	Recovery
Zero-Surface	5.5	5422	11.60	0.063	
0 - 6"	30.1	29673	5.70	0.169	
6 - 12"	35.2	34701	6.45	0.224	
12 - 18"	42.5	41897	3.88	0.163	
18 - 24"	38.1	37559	3.51	0.132	
24 - 30"	29.1	28687	3.93	0.113	
30 - 36"	26.8	26420	3.14	0.083	
36 - 42"	31.8	31349	4.36	0.137	
42 - 48"	37.4	36869	3.08	0.114	
48 - 54"	38.3	37757	3.03	0.114	
54 - 60"	98	96609	2.19	0.212	
Total	412.8	406943		1.524	42.24

14 additions @ 0.2577 g. each = 3.6078g. Total DIMP added.

Table IV

Sample Reproducibility Factors (SRF) Lysimeter Cores

Soil Type	SRF
Fullerton	0.64
Chino	0.82
Brawley	0.59
Ventura	0.61
Walnut	0.70

It can be seen from the sample reproducibility factors in Table IV that the core sample weights are somewhat lighter this period than in the past. This is due to the fact that we are now allowing a two week drainage period between water additions and that this and the warmer weather combine to give somewhat drier samples.

The initiation of lysimeter experiments parallel to the two described above with the substitution of DCPD (dicyclopentadiene) for DIMP is awaiting a resolution of the DCPD analysis problem. As described in last month's report the attempted extraction of DCPD from soil has been less than quantitative and was a function of both soil type and concentration. Further attempts to develop more efficient extraction/analysis procedures have, as yet, been unsuccessful.

The analysis of DCPD is discussed in another section of this report.

RANGE FINDING PLANT GROWTH EXPERIMENTS

The analysis of the harvested plant tissues from the range finding growth tests has continued. Data from these (and previous) analyses for tomato plants is shown in Table V. Figure 3 is a plot of this data. The dotted line in this plot is the level where the concentration of DIMP in the plant tissue is equal to its concentration in the nutrient bath.

Table VI shows the bioaccumulation factors determined by chemical analysis of DIMP in plant tissues at time of harvest. These values are determined on a fresh cut weight basis. The moisture contents of these tissues has been measured but are not tabulated here. Most of the plants had completed their life cycle by the time they were harvested and their tissues were well on the way to drying out.

Table V

Hydroponic Tomato Leaf Bioaccumulation Factors (DIMP)
(Fresh Cut Basis)

Time From Inoculation (Days) \ DIMP Concentration in Nutrient Bath	1	10	100	1000
13	10.4	5.5	5.0	
15				15.1
41	10.1	3.9	4.8	
54			2.5	
61		1.2		
88	0.3	0.7	8.3	
149	0	3.9	3.6	

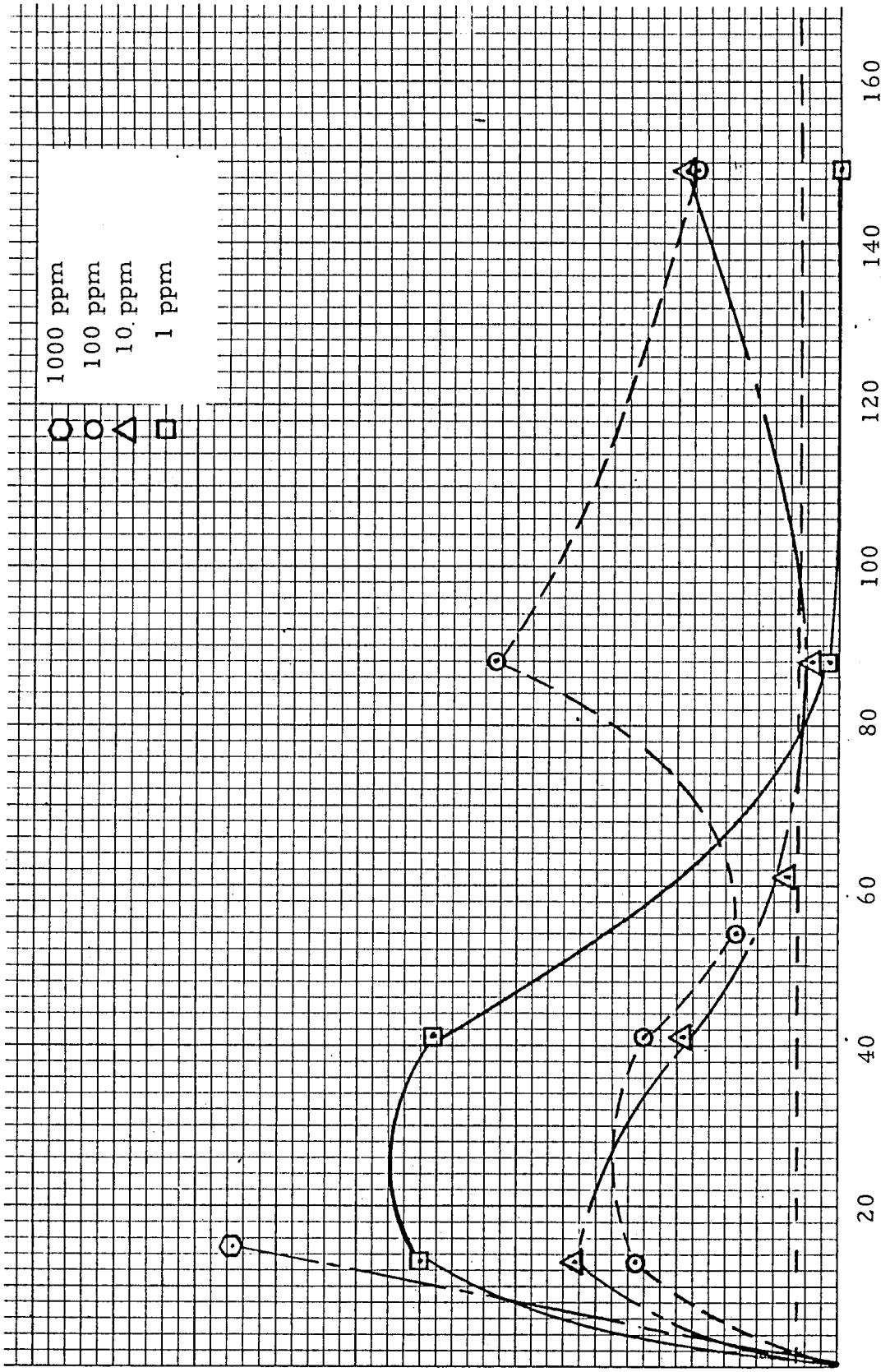
1000 ppm
100 ppm
10 ppm
1 ppm
Bioaccumulation Factor
20
16
12
8
4
20
40
60
80
100
120
140
160
Days from Inoculation

Figure 3.

Table VI

Bioaccumulation Factors for Various Plant Tissues

(Fresh Cut Basis)

Plant Type \ DIMP Concentration in Nutrient Bath		1	10	100	1000	Days from Inoculation
Meadow Fescue						
	Root	3.2	0.34	0.54	----	153
	Leaves	0	1.01	0.77	----	"
Sugar Beet						
	Root	0	0	0.60	----	153
	Fruit	0.17	0.04	0.19	----	"
	Leaves	0	2.23	0	----	"
Carrot						
	Fruit	0.25	0.09	0.17	----	153
	Stem	3.40	0.40	0.16	----	"
	Leaves	9.51	0	0.63	----	"
Juniper						
	Root	0.74	1.81	2.80	1.67	165
	Stem	0.64	0.68	0.61	0.20	"
	Leaves	6.29	1.42	1.14	0.50	"
Corn						
	Root	0	0.66	0.22	----	163
	Stem	3.57	4.00	0.67	----	"
	Leaves	4.99	0	0.97	----	"
Wheat						
	Root	1.03	1.59	0.71	----	163
	Stem & Leaves	1.00	2.09	0.77	----	"

It can be seen from the table that most of the bioaccumulation values are relatively low. Comparing these values with those obtained approximately two months earlier shows that the bioaccumulation in all the plants reaches a peak after several months growth and then falls off as the plant approaches the latter part of its life cycle. This appears to be true of all the concentrations of DIMP tested. A set of composite plots of this data (Table VI) for several species of plant leaves is shown in Figures 4 and 5.

The DCPD analysis in plant tissues has been developed to the extent that standard DCPD added to plant tissue can be recovered quantitatively from a tissue homogenate. The standard recovery experiment proceeds as follows: Add a known weight of DCPD (neat) to approximately one gram of plant tissue (e.g. tomato leaf) in a homogenizer. Add 5.0 milliliters of absolute methanol to the homogenizer and crush the tissue therein. Centrifuge the homogenate and transfer a 1.0 milliliter aliquot of the supernatant liquid to another centrifuge tube. Add to this 1.0 milliliter of distilled water followed by 1.0 milliliter of carbon disulfide, (CS_2), mix well and centrifuge. Take a sample of the lower CS_2 layer in a microsyringe and subject it to gas-liquid chromatography as specified for DCPD. A typical series run in this manner gave recovery values ranging from 99.9 % to 107.0% DCPD. In this same sample which contained 760 ppm DCPD in tomato leaves a second CS_2 extraction of the Methanol/water layer yielded a 2ppm solution indicating a 99.7% liquid extraction efficiency in this case.

The DCPD plant cuttings that have been collected during the hydroponic range finding tests are being analyzed by the above method for DCPD content.

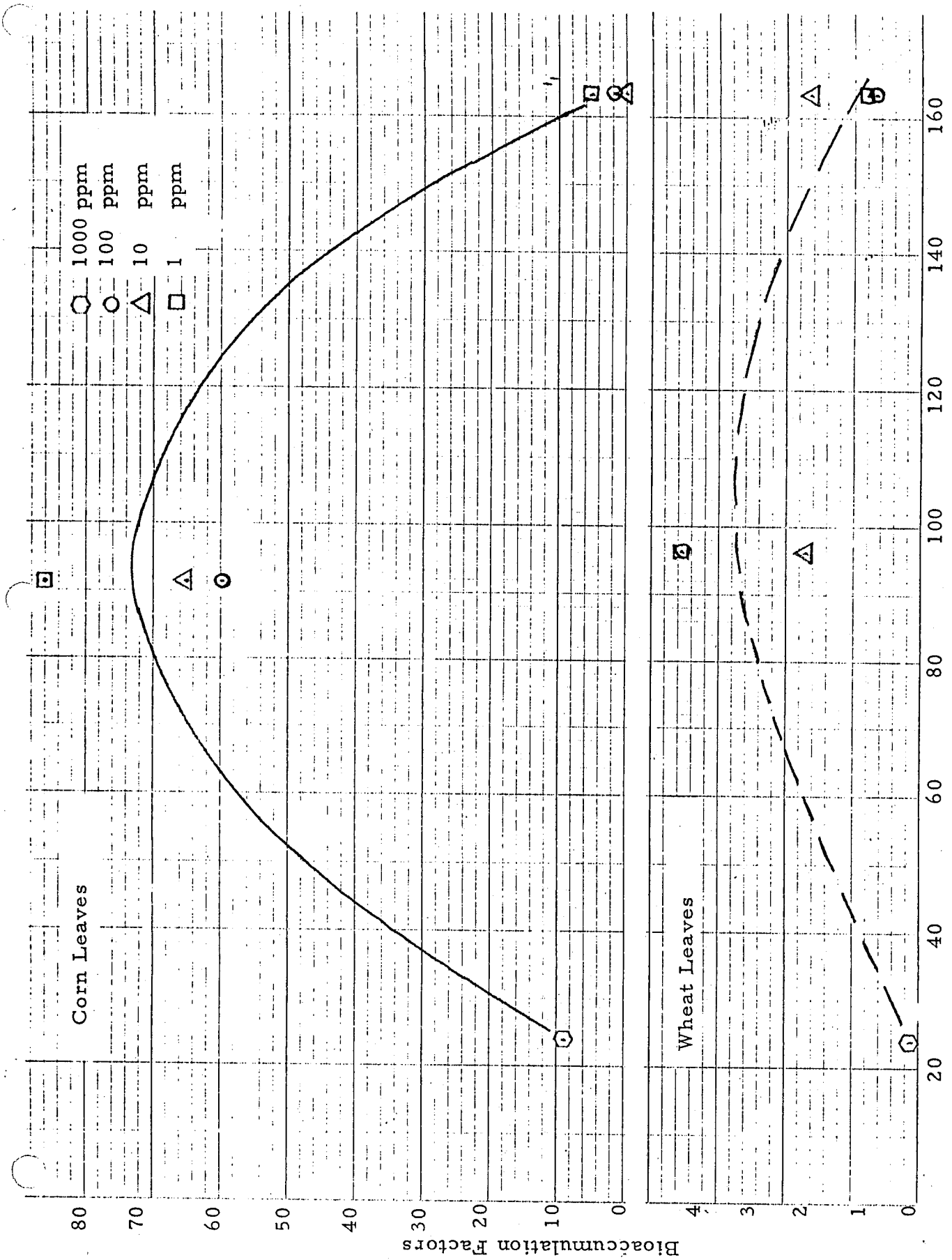

Figure 4. Bioaccumulation of DIMP in Hydroponically Grown Plant Tissues (1)

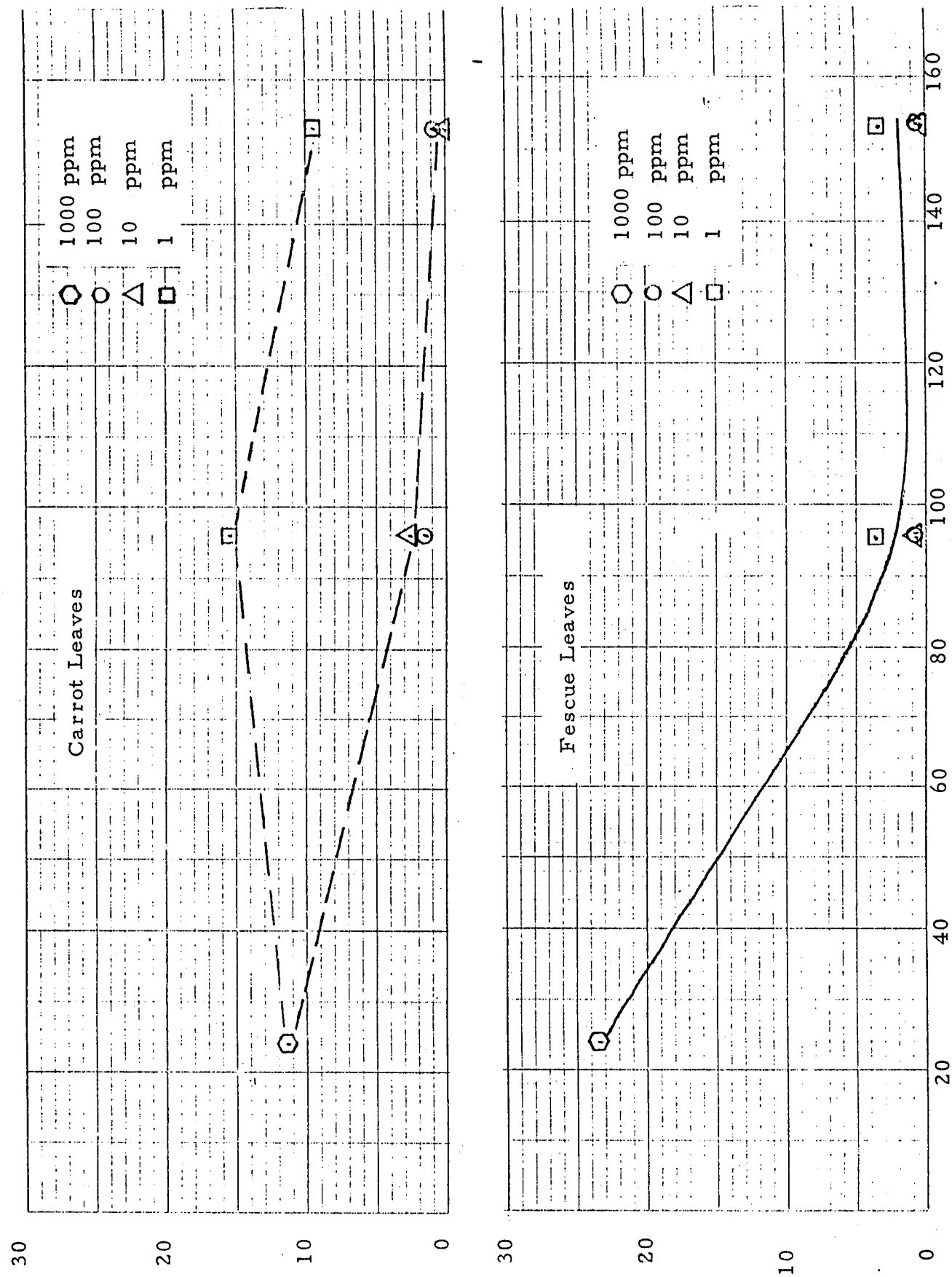

Figure 5. Bioaccumulation of DIMP in Hydroponically Grown Plant Tissues (2)

SOIL CULTURE EXPERIMENTS

Construction of the new three room, 14 x 42 foot greenhouse to be used in the soil culture experiments has been completed (Figure 6) and it has been outfitted with heaters and coolers. Fullerton sandy loam has been loaded into several hundred polyethylene egg cans which will serve as growth containers for the soil culture experiments. These experiments will commence upon completion and approval of the soil culture test plan.

PROPOSED ACTIVITY DURING MAY 1976

- Complete soil culture test plan and begin soil culture growth experiments.
- Establish an analytical procedure for DCPD in soil and initiate DCPD lysimeter tests.
- Continue analysis of DCPD in hydroponic range finding plant tissues.
- Initiate limited soil culture of juniper, rice and cucumber plants for qualitative uptake and accumulation determinations.